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Probe for electrical measurement methods, and use of a flexible probe for production of an inflexible probe

The invention is based on a probe for electrical measurement methods as claimed in the distinguishing part of claim 1, and on the use of a flexible probe for production of an inflexible probe as claimed in claim 13.

DE 197 48 556 A1 discloses a probe for eddy current measurement having ferromagnetic signal amplification, with the signal amplification being produced by a rigid ferritic core. Only test bodies with a planar surface can be measured by a probe which is formed from a rigid substrate on which planar coils are fitted. If the surfaces are uneven, the shape of the probe must be matched to a surface of the test body, otherwise, incorrect measurement values will be obtained.

A probe with eddy current measurement and with ferromagnetic signal amplification for planar test bodies is also known from US-PS 6,002,251.

US PS 5,389,876 discloses a probe for eddy current measurement, although this produces only weak signals.

The object of the invention is thus to specify a probe for electrical measurement methods, which can be used for differently curved surfaces on a test body.

The object is achieved by the probe together with the substrate being flexible.

Further advantageous refinements of the probe according to the invention are mentioned in the dependent claims.

The probe can be matched to radii of curvature of, for example, 50 mm or more.
Flexibility is advantageously achieved by using a substrate that is formed from a flexible sheet, and by advantageously using polyimide for the probe.

By way of example, two in particular planar coils, in particular composed of copper, are advantageously fitted to the flexible sheet as electrical components.

The flexibility of the probe is also maintained by a flexible rear key for the electrical components.

A polymer sheet which is filled with a ferrite is advantageously used for the flexible rear key, advantageously allowing ferromagnetic signal amplification.
Thin flexible metal sheets composed of ferrite may likewise be used. An encapsulation component having ferrite particles can also be used in this case, with the encapsulation compound being easily plastically deformable.

Exemplary embodiments of the invention are illustrated in a simplified and schematic form in the drawings, in which:

Figure 1 shows an arrangement of an exciter and a signal coil,
Figure 2 shows a first exemplary embodiment of a probe according to the invention, and
Figure 3 shows a further exemplary embodiment of a probe designed according to the invention.

Figure 1 shows an excitation coil 4 and a signal coil 7 as electrical components arranged on a plane, according to the prior art.
The signal coil 7 is surrounded, for example, by the

excitation coil 4. With regard to the further construction of the example of the

excitation coil 4, the signal core 7 and an evaluation system using a probe, reference should be made to DE 197 48 556 A1, which is expressly intended to be a part of this disclosure.

The excitation coil 4 and the signal coil 7 are electrically isolated from one another. The signal coil 7 in this example is in the form of a difference probe. The spatial resolution is governed by the distance between the centres of gravity of the two coil elements, the so-called baseline.
The excitation winding 4 surrounds the coil elements of the signal coil 7 symmetrically, for example, so that this ensures compensation for the excitation field.
Exemplary embodiments of probes are:
An XXL probe has a baseline of 3.3 mm, an excitation coil with 21 turns, and a signal coil with 8 turns.
An S probe has a baseline of 2.3 mm, an excitation coil with 9 turns, and a signal coil with 5 turns.

A probe which, inter alia, comprises an excitation coil 4 and a signal coil 7 is moved in a scanning direction 13, identified by an arrow, over a surface of a test body 10 (indicated by a dashed circumferential line), with the probe 1 coming to rest with a contact surface 37 (Figure 2) on the test body 10. By way of example, the test body 10 contains defects in the form of cracks, which influence a magnetic signal in the excitation coil 4, by which means it is possible to detect the defects in the interior of the test body 10, and on its surface.

Figure 2 shows a first exemplary embodiment of a probe 1 for electrical measurement methods according to the present invention. A sheet which is flexible, for example, is used as the substrate 16, which rests directly on the test body. A polyimide sheet is

preferably used.

The excitation coil 4 and the signal coil 7 are arranged, for example in a planar form, on the substrate 16, that is to say the coil comprises only

one conductor track, which runs only on a plane. The coils 4, 7, as electrical components, can be fitted to the sheet 16 by means of a galvanic process or a wet-chemical method.
An adhesive 19, which connects a rear key 22 to the substrate 16, is, but need not necessarily be, applied to the substrate 16 and to and around the coils 4, 7.

The rear key 22 is likewise flexible. A ferrite material (for ferromagnetic signal amplification) with a permeability μ of up to 100 is preferably used as the material for the rear key 22. By way of example, at least one electrical supply line 31 for the coils 4, 7 for a measurement system according to DE 197 48 556 A1 is passed through the rear key 22.

A polymer sheet 25 filled with ferrite particles may be used as the rear key 22.

It is likewise possible to use a thin flexible ferrite metal sheet for signal amplification.

The polyimide sheet 16 has, for example, a thickness of 25 μm, the copper coil has a thickness of 17 μm, the adhesive extends over a thickness of about 30 μm, and the polymer sheet that is filled with ferrite extends over a thickness of 200 to 600 μm.

This layer stack remains sufficiently flexible to allow the layer stack to be matched to different radii of curvature of the test body 10, for example, 50 mm and more, without any problems.

Figure 3 shows a further exemplary embodiment of a planar probe 1 designed according to the invention. The rear key 22 can also be ensured by means of an encapsulation material 34, in which ferrite powder is mixed. The mean diameter of the ferrite particles is, for example, about 10 µm. The encapsulation compound is and remains easily plastically deformable after a curing process, thus ensuring that the probe 1 is permanently flexible.

An encapsulation probe such as this can also be used in order to produce a rigid probe 1 for specific curved surfaces. In this case, an encapsulation compound 34 is used which can be cured in a state in which it is deformed in this way, such that it can subsequently be plastically deformed only with difficulty, and is thus permanently matched to the contour of specific test bodies 10. The advantage of the method in this case is that a flexible probe 1 is first of all matched to a surface of a test body 10 without any major effort, and the encapsulation compound 34 is subsequently cured, so that there can be no air gap between the contact surface 37 of the sheet 16 and the curved surface of the test body 10 to corrupt the measurement result.

As an electrical measurement method, the probe 1 which, by way of example, has two coils 4, 7 or only one coil as well as the ferromagnetic signal amplification 22, can be used for eddy current measurement which serves, for example, to detect defects in or on metallic components 10.